VOL. 5 NO. 4 APR. 1987

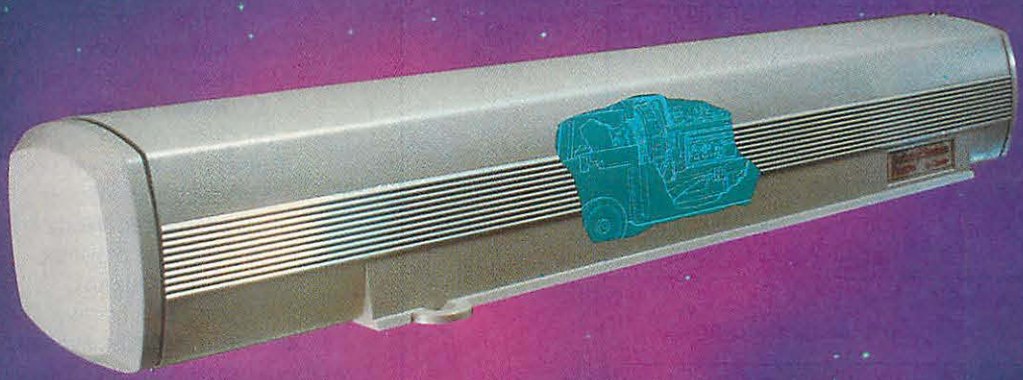
COMPUTER DIGEST

A NEW KIND OF MAGAZINE FOR ELECTRONICS PROFESSIONALS

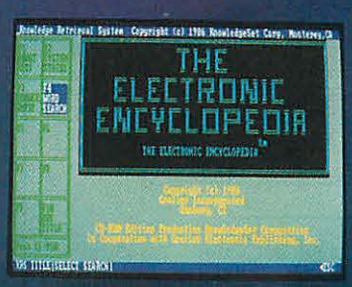
A GERNSBACK PUBLICATION

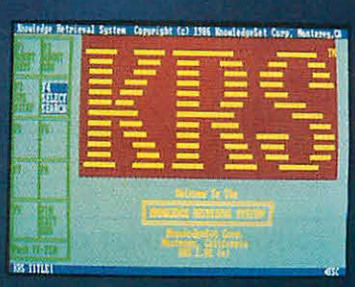
THE CAUZIN SOFTSTRIP SYSTEM

Paper goes digital



GROLIER'S ELECTRONIC ENCYCLOPEDIA





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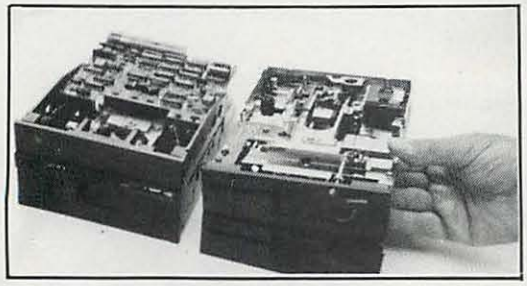

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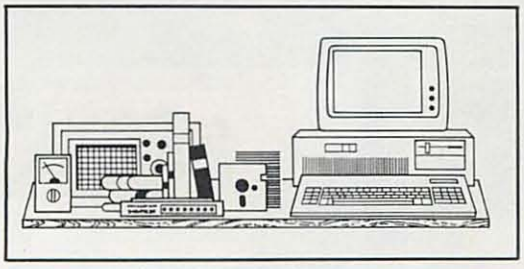

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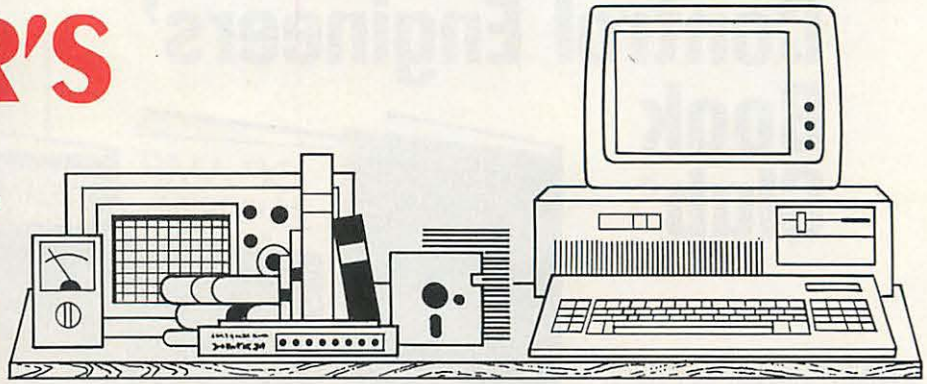

HERCULES GRAPHICS CARD PLUS

At a time when color-graphics systems for the IBM-PC are more prolific than ticks on a hound, one would hardly expect to see a monochrome graphics board squaring off with the competing color-graphics heavyweights. But into the midst of the fray comes the new Hercules card (Hercules Computer Technology 2550 Ninth St., Berkeley, CA 94710).

Like the old Hercules card, the new *Plus* supports both monochrome text and 720-by-348 pixel graphics on the IBM monochrome display monitor or its equivalent. The *Plus* is hardware and software compatible with all applications developed for the original card, including tough customers like Lotus 1-2-3, Flight Simulator, and Sub-Logic's Jet. Anything and everything that ran on the old card comes off without a hitch on the new one.

RamFont

What sets the *Plus* card apart from the original is something called RamFont, a hardware-based graphics mode that enables the PC to display multiple fonts and limited graphics on the screen as easily as older graphics cards displayed standard monochrome text. (See Fig. 1)

Actually, in addition to the original two modes, there are two RamFont modes: 4K RamFont and 48K RamFont. Each uses the indicated amount of display memory, and each serves a different purpose.

The 4K RamFont mode is essentially a superset of the standard text mode. Traditionally, text screens have been limited to one type and style of displayed text; the patterns of which are indelibly etched into the BIOS ROM IC of the computer. With the *Plus*, Hercules provides a number of diskette-based fonts, including Bold, Greek, "Medieval," Sans Serif, "Future," and about 25 others, any one of which can replace the standard character set, thereby allowing you to customize the display to your liking. The selected font is accessible by any and all text-mode software in the normal fashion. Hercules provides a font editor so that you can create your own fonts, or modify theirs.

The 48K RamFont mode is completely new and totally revolutionary. In this mode, each character is defined by twelve bits, rather than the customary eight. So programs can display as many as 3,096 characters in different sizes, shapes and typefaces.

Using drivers supplied by Hercules, the 48K RamFont mode can also be used to display graphics screens from Lotus 1-2-3 (Version 2) and Symphony. (Lotus' new scientific word processor, Manuscript, makes use of the 48K RamFont mode; watch for a review in an upcoming issue.—*Editor*). The drivers actually replace the standard eight-

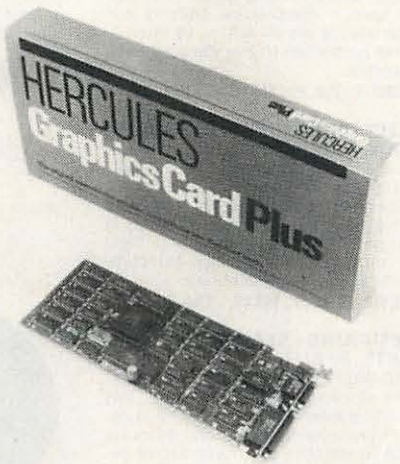

FIG. 2

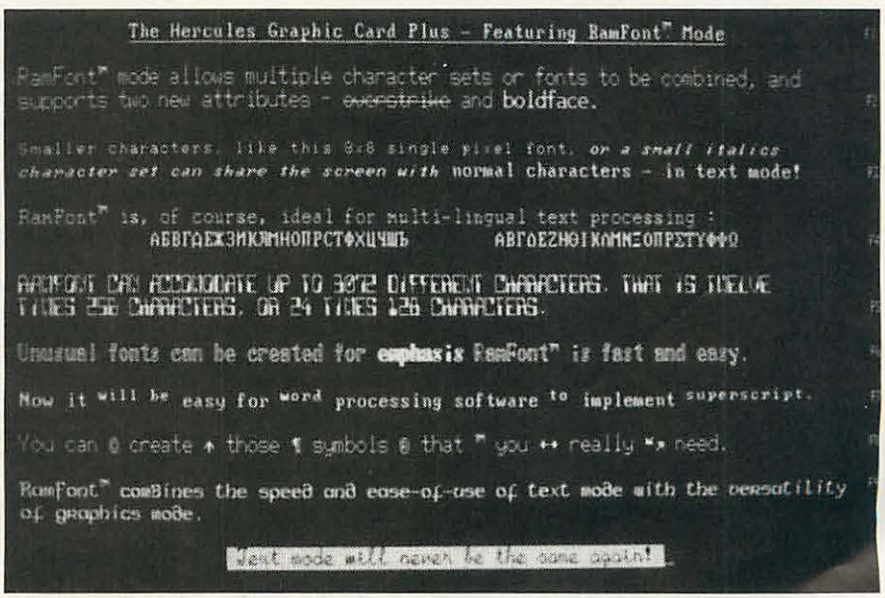
The Hercules Graphic Card Plus - Featuring RamFont™ Mode
RamFont™ mode allows multiple character sets or fonts to be combined, and supports two new attributes - overstrike and boldface.
Smaller characters, like this 6x8 single pixel font, or a small italics character set can share the screen with normal characters - in text mode!
RamFont™ is, of course, ideal for multi-lingual text processing :
AБВГДЕЖЗИКЛМНОПРСТФХЦЧШЪ АБГДЕZНӨІКЛММΣОПРΣТУФΨΩ
RAMFONT CAN ACCOMODATE UP TO 3072 DIFFERENT CHARACTERS. THAT IS TWELVE TYPES 256 CHARACTERS, OR 24 TYPES 128 CHARACTERS.
Unusual fonts can be created for emphasis RamFont™ is fast and easy.
Now it will be easy for word processing software to implement superscript.
You can 0 create ↑ those ¶ symbols 0 that " you ↔ really "» need.
RamFont™ combines the speed and ease-of-use of text mode with the versatility of graphics mode.
Next mode will never be the same again!

FIG. 1

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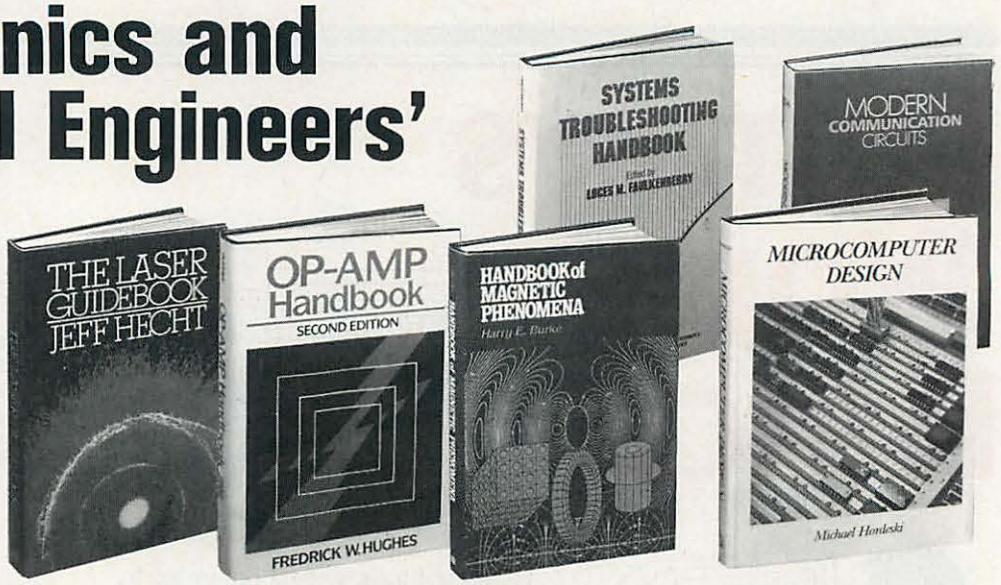

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bit ASCII character codes with the 12-bit character codes required by RamFont. And through careful definition and manipulation of the character patterns involved (lines and solids included), complex graphic imagess can be created on-screen. Vendor software support for the new 48K RamFont mode is expected.

A point to consider, however, it that none of the 4K or 48K RamFont characters can be printed on paper. They are screen images only, and remain that way. Calls to the printer result in standard ASCII characters.

Printer port

Overshadowed by RamFont's glitter is a unique parallel-printer port. It's unique in that it is controlled by a single, proprietary IC that replaces about 18 standard TTL IC's. It is configured to function only as LPT1; to disable it, you must remove the IC.

Priced at $299—a full $200 less than the original Hercules card—the Hercules *Graphics Card Plus* is a winner. If you're in the market for a monochrome graphics card, check this one out first.

GROLIER'S ELECTRONIC ENCYCLOPEDIA

What is the value of information? The answer to that question depends on the kind of information—and on whether it's accessible. If it's inaccessible, it's worth just about what it would be if it didn't exist at all: Nothing. That may seem obvious, but there's more to the idea than may appear at first glance. Our age has already been called the Information Age, but technologies that are here now, albeit in rather primitive form, promise to eclipse previous advances in both the storage and processing of information.

In fact, it's already happening in several areas. Almost everyone is familiar with optical storage technology, because the audio compact disk is one example of that technology. You may have heard of the CD-ROM—it's physically the same as an audio CD, but it usually carries information that is to be processed by computer.

We discussed the organization of the audio compact disk in the August 1986 issue; an upcoming issue in 1987 will discuss CD-ROM technology. Meanwhile, we've been discussing CD-ROM products as they've been released. For example, see our review of the PC-SIG CD-ROM in the March issue. That CD-ROM contains the equivalent of more than 600 diskettes of programs and data files for the IBM-PC.

Another CD-ROM product, *The Electronic Encyclopedia,* has been released by Grolier Electronic Publishing, Inc. (Sherman Turnpike, Danbury, CT 06816), in cooperation with Activenture Corp. (Monterey, CA). If you've ever used a computer with the CP/M operating system, you may be interested to know that its inventor, Gary Kildall, is head of Activenture.

The encyclopedia is contained on a single CD-ROM; an auxilliary diskette contains Activenture's Knowledge Retrieval System (KRS), installation software, and drivers for several popular CD-ROM drives (Hitachi, Phillips, and Sony models). Unlike some CD-ROM products, KRS does not require the hardware drivers to be included in your CONFIG.SYS file, so there is little possibility for conflict with other programs or devices. The program requires 256K of RAM, and it can run on any monochrome or color IBM-PC display.

What is it?

The encyclopedia itself is based on Grolier's *Academic American Encyclopedia,* which was first published in 1980. The text of *The Electronic Encyclopedia* has been available electronically through online networks since 1982. The CD-ROM contains a two-part 110-megabyte database. One part, comprising about 60 megabytes, contains the text of the encyclopedia; the other, comprising about 50 megabytes, is an index that pinpoints every occurance of every word in the main database. The database contains about nine million words and thirty thousand entries. In

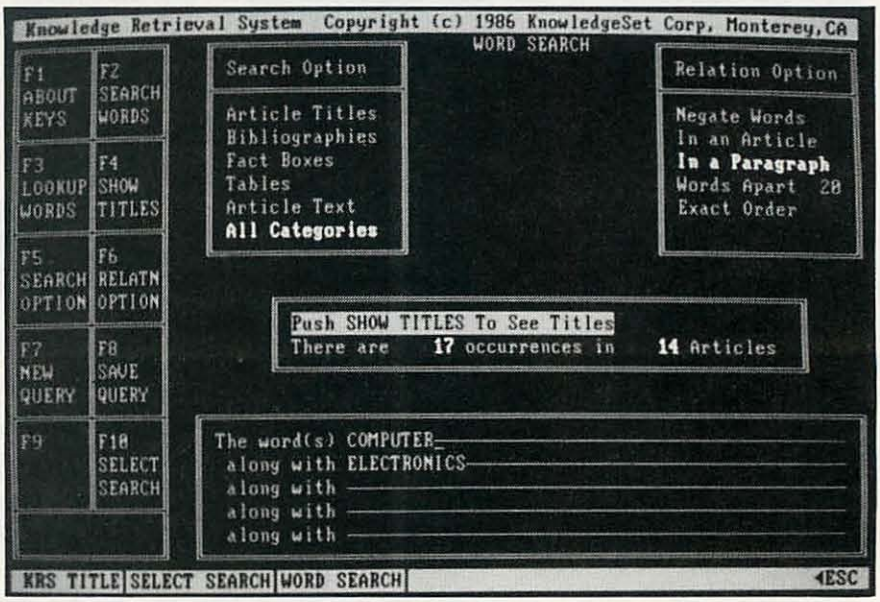


FIG. 3

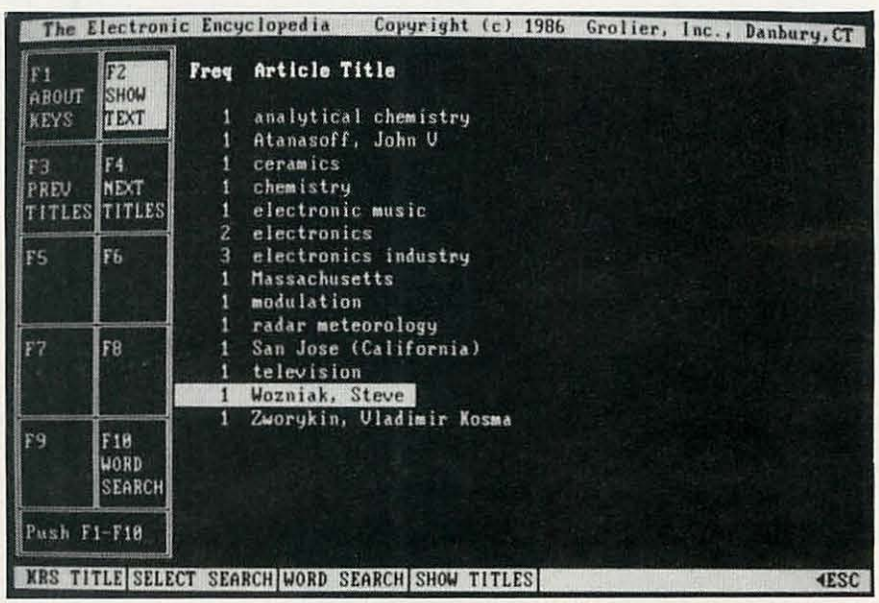


FIG. 4

printed form it takes ten thousand pages, or about two feet of shelf space, to hold the entire encyclopedia. About 35% of the entries concern science and technology; about 36% concern the humanistic disciplines; the remainder concern the social sciences, geography, sports, and contemporary life.

Enough statistics—what's it like to use the encyclopedia, and how is the encyclopedia itself?

Purpose and implementation

To begin with the latter, let's quote Grolier's three stated purposes for *The Electronic Encyclopedia* as they appear in the *User's Guide:*

- To provide quick access to definitive, factual information.
- To provide a readily intelligible general overview of a subject that does not compel the reader to grasp intricate subtleties or wade through drawn-out historical analysis.
- To provide a starting place for further research by isolating key concepts, outlining the structure of the subject, and directing the reader to more specialized primary and secondary sources of information.

Does *The Electronic Encyclopedia* meet those goals? In general, yes. If you wanted graduate-level information on computer science or Shakesperean drama, the encyclopedia wouldn't help. In fact, as encyclopedias go, *The Electronic Encyclopedia* is rather weak; it's certainly no *Brittanica.* But if you need a quick overview of a subject, or simply a place to start, it can be valuable.

The real strength of *The Electronic Encyclopedia* arises from its electronic form and from the indexing and collating abilities that form provides. It would be extremely difficult with any printed encyclopedia to find all articles containing both the words *computers* and *electronics.* But with *The Electronic Encyclopedia* it's simple, as shown in Fig. 3.

After choosing a search topic, you're presented with a list of articles, as shown in Fig. 4, which you may examine one by one. You do so by moving the highlight bar with the cursor keys, and then pressing F2. The text display appears as shown in Fig. 5. In addition, complicated articles can be viewed in outline format.

When you find an interesting article, you can print the text or save it to a standard ASCII text file, for inclusion in a word-processing document.

A separate KRS screen allows you to set the screen colors, type of CD-ROM drive, and operating parameters. See Fig. 6.

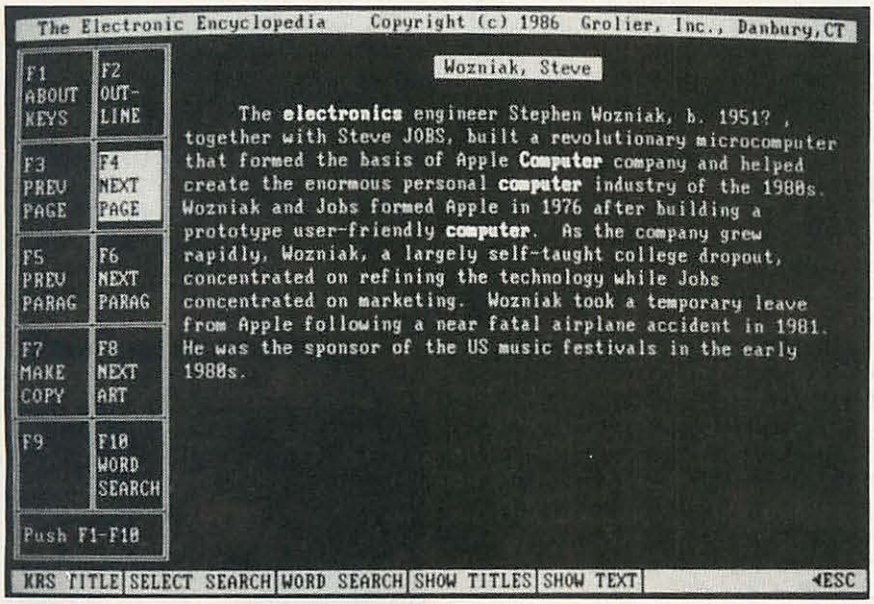

The Electronic Encyclopedia Copyright (c) 1986 Grolier, Inc., Danbury,CT
F1 ABOUT KEYS
F2 OUT-LINE
F3 PREV PAGE
F4 NEXT PAGE
F5 PREV PARAG
F6 NEXT PARAG
F7 MAKE COPY
F8 NEXT ART
F9
F10 WORD SEARCH
Push F1-F10
Wozniak, Steve
The electronics engineer Stephen Wozniak, b. 1951? , together with Steve JOBS, built a revolutionary microcomputer that formed the basis of Apple Computer company and helped create the enormous personal computer industry of the 1980s. Wozniak and Jobs formed Apple in 1976 after building a prototype user-friendly computer. As the company grew rapidly, Wozniak, a largely self-taught college dropout, concentrated on refining the technology while Jobs concentrated on marketing. Wozniak took a temporary leave from Apple following a near fatal airplane accident in 1981. He was the sponsor of the US music festivals in the early 1980s.
KRS TITLE
SELECT SEARCH
WORD SEARCH
SHOW TITLES
SHOW TEXT
ESC

FIG. 5

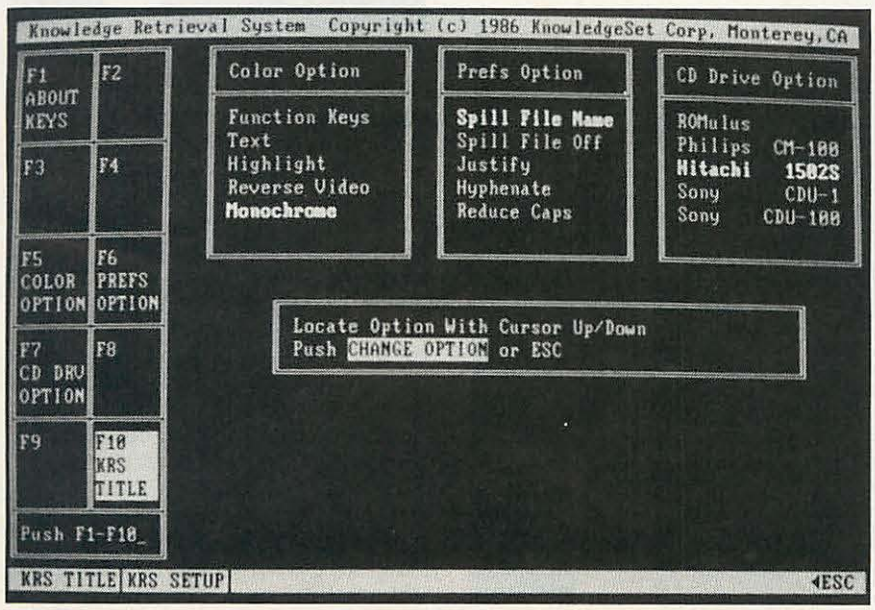


FIG. 6

Evaluation

The KRS software works fairly well in helping you to extract information from the encyclopedia, but it does have a few rough edges. For example, we wanted to open a file and collect all information on a topic in that file for perusal later. It turns out that you must assign a new output file name each time you enter a new article. Doing so requires you to traverse several levels of menus and to wait an appreciable amount of time.

In addition, some menu choices are not obvious, and it takes either some experimentation or a close study of the manual to learn how to accomplish simple tasks.

Last, although it's obvious that *The Electronic Encyclopedia* was designed not for the power user, but for the masses, a command-driven mode that bypasses the menus would have been nice, especially if it could be run from DOS in batch mode.

However, we think the real importance of *The Electronic Encyclopedia* lies not in what it itself can do, but in the avenues of design it opens for those to follow. KRS has become a standard by virtue of being first; others will emulate its good points and correct its faults.

The situation reminds us of what happened to Kildall's earlier brainchild, CP/M. Indeed, we would be surprised if some product didn't surpass KRS just as MS-DOS surpassed CP/M. We just hope that Kildall will gain the recognition and rewards he deserves for being a true pioneer, not just another copy-cat imitator.

Our methods of dealing with information are going to have a drastic effect on how we work, on the way we live, and even on the way we play. KRS and *The Electronic Encyclopedia* provide us a glimpse into the kind of information-processing systems our children will take for granted while wondering how earlier ages managed to accomplish anything.

Thanks to Amdek Corporation (2201 Lively Blvd., Elk Grove Village, IL 60007) for use of their *Color 722* EGA monitor, which was used for our color cover shots.

HALL-COMSEC'S WIRETAP, HAYES' TRANSET 1000, DISC INSTRUMENTS' μLYNX TRACKBALL, AND FINOT GROUP'S KEEP TRACK

If you've ever connected any two pieces of computer gear together, you know that the so-called RS-232 standard is really just a myth. Many companies manufacture devices designed to help you conquer a troublesome RS-232 hook-up, but a device called the *WireTap*, from Hall-Comsec, Inc. (901 Sandy Cove Lane, Ft. Collins, CO) is inexpensive ($37.50), and it can save you much grief. It's shown in Fig. 7.

The *WireTap* is a module with male and female DB-25 connectors on either end. Between them is a nine-position DIP switch, two rows of socket connectors, and two rows of LED's. Near the male end, and connected to pins 2–8, 12, 20, and 22, are red LED's; at the female end, and connected to the same pins, are green LED's. The red LED's light on high signals; the green on low. Pin 7 is connected straight through; no other pins are accessible.

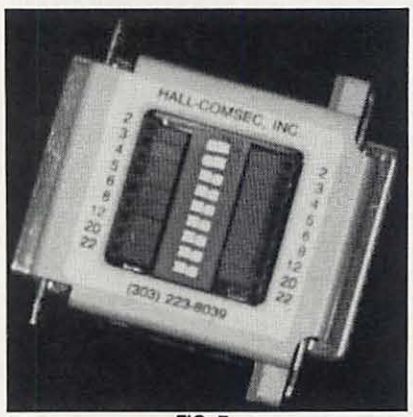


FIG. 7

To connect a pin on one end to the pin opposite it (pin 2 to pin 2, for example), just close the appropriate switch. To connect a pin to a different pin (pin 2 to pin 3, for example) use the appropriate socket connectors and a short length of solid wire. Hall-Comsec has thoughtfully provided several such wires.

The *WireTap* is small enough to tuck away in a corner of your briefcase and carry with you wherever you go. It's helped us out of more than one jam.

KeepTrack Plus

Maintaining the files on a hard disk can be a real pain; many programs on the market profess to help ease the task. One of the better ones is called *KeepTrack Plus*. In operation, the program gives a tree-structured view of your directories and files. You can tag files across multiple directories, and then view, copy, delete, and back them up. You can copy an entire directory (with all subdirectories, if desired) by a single keypress. *KeepTrack Plus* will create the appropriate tree structure in the target drive, if necessary. You can back up files to two diskettes simultaneously, and create lists of files not to back up. The screen shot in Fig. 8 should give you an idea of how easy it is.

KeepTrack Plus comes with two manuals. One teaches the fundamentals of DOS, including filenames, directory structure, batch files, etc. The other manual is for users who are ready to start using *KeepTrack Plus* without training. At only $79 (plus $5 shipping), it's a real bargain. Contact The Finot Group, 2390 El Camino Real, Suite 3, Palo Alto, CA 94306.

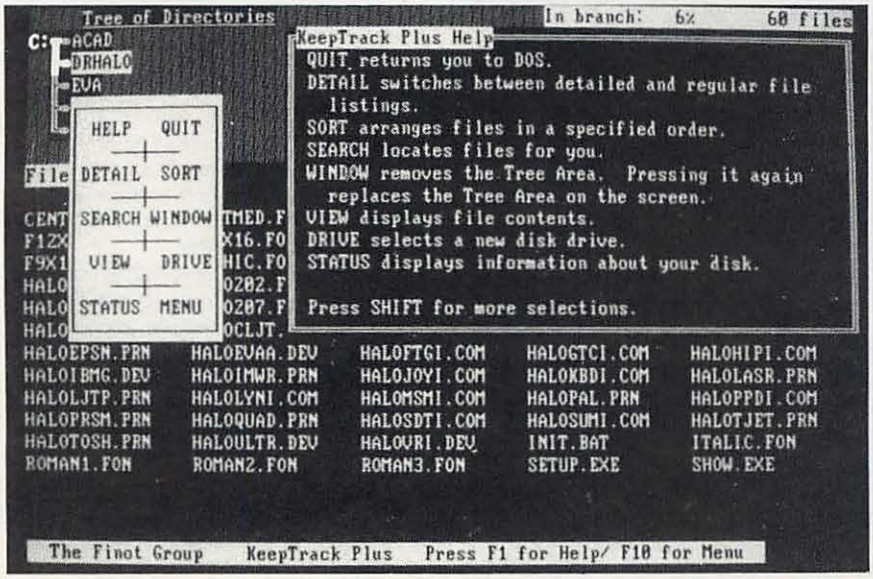

Tree of Directories
In branch: 6% 60 files
C:
ACAD
DRHALO
EVA
KeepTrack Plus Help
QUIT returns you to DOS.
DETAIL switches between detailed and regular file listings.
SORT arranges files in a specified order.
SEARCH locates files for you.
WINDOW removes the Tree Area. Pressing it again replaces the Tree Area on the screen.
VIEW displays file contents.
DRIVE selects a new disk drive.
STATUS displays information about your disk.
Press SHIFT for more selections.
HELP QUIT
File DETAIL SORT
SEARCH WINDOW
VIEW DRIVE
STATUS MENU
HALOEPSN.PRN HALOEVAA.DEV HALOFTGI.COM HALOGTCI.COM HALOHIPI.COM
HALOIBMG.DEV HALOIMWR.PRN HALOJOYI.COM HALOKBDI.COM HALOLASR.PRN
HALOLJTP.PRN HALOLYNI.COM HALOMSMI.COM HALOPAL.PRN HALOPPDI.COM
HALOPRSM.PRN HALOQUAD.PRN HALOSDTI.COM HALOSUMI.COM HALOTJET.PRN
HALOTOSH.PRN HALOULTR.DEV HALOVRI.DEV INIT.BAT ITALIC.FON
ROMAN1.FON ROMAN2.FON ROMAN3.FON SETUP.EXE SHOW.EXE
The Finot Group KeepTrack Plus Press F1 for Help/ F10 for Menu

FIG. 8

FIG. 9

Hayes *Transet 1000*

There are printer buffers and then there are printer buffers like the one shown in Fig. 9. The *Transet 1000* from Hayes Microcomputer Products, Inc. (5923 Peachtree Industrial Blvd., Norcross, GA 30092) is a printer buffer—but it's also a whole lot more. You can use it to buffer data from a computer to a printer while simultaneously (or separately) buffering data from a modem. You can use it to connect two computers to one printer, or one computer to two printers. You can even design your own "communication paths" through it.

The *Transet 1000* has two bi-directional serial ports and an output-only parallel port. It comes in two versions: with 128K and 512K of RAM, which have suggested retail prices of $399 and $549, respectively, and many dealers discount both versions.

As a printer buffer, you can set it to print multiple copies, as well as to format raw ASCII text as well as most word processing programs.

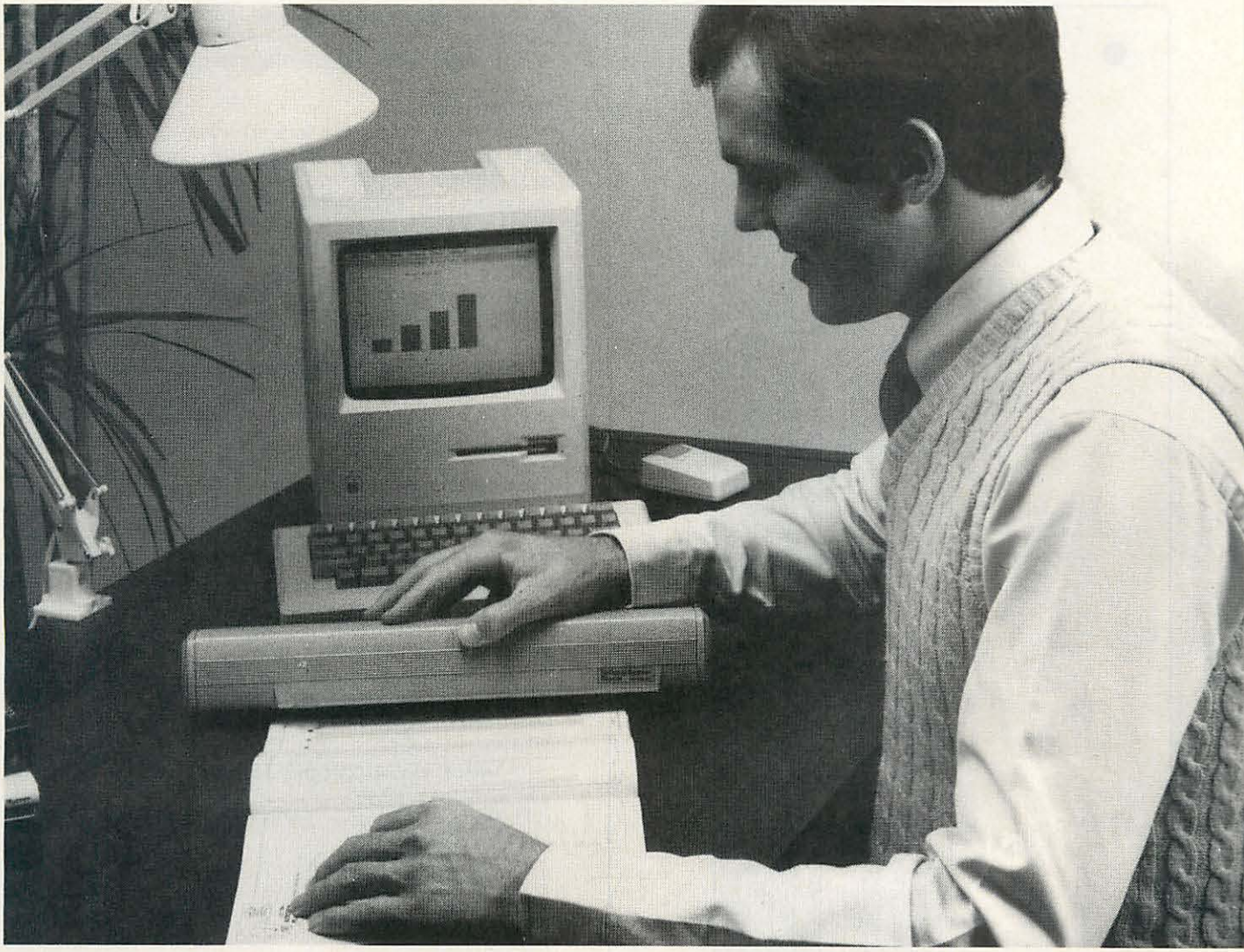
Disc Instruments μLynx

Around the computer shack bugs are bad, but rodents can be good. Some people swear by mice; others hate them. A compromise, and a good one, is sold by Disc Instruments (102 East Baker Street, Costa Mesa, CA 92626), a subsidiary of Honeywell. It's called the μLynx (pronounced microlynx), and it provides the convenience features of a mouse without the hassle.

FIG. 10

Its biggest selling point is that you don't need to clean your desk—a rolling ball in the top of the unit performs the "mouse" functions. In addition, you don't need to dedicate a serial port to it; through a special dual connector, it hooks up between your keyboard and your computer. No separate power supply is necessary.

In operation, it greatly speeds cursor movements in programs like AutoCAD, Dr. Halo, etc. And it should be compatible with most programs, because it emulates operation of the Microsoft mouse.



THE CAUZIN SOFTSTRIP SYSTEM

A new storage technology promises to revolutionize the way computer programs and all sorts of other data are distributed.

JEFF HOLTZMAN, TECHNICAL EDITOR

Personal computers have proven themselves extremely valuable to scientists, engineers, students, office workers, writers, musicians, artists and many others. But one problem that has often plagued personal computer users is the dissemination of information. Typing program listings (from **ComputerDigest** and other magazines) into a computer is time consuming and prone to error. Not only is time wasted in typing, but time is also wasted in debugging one's typing errors.

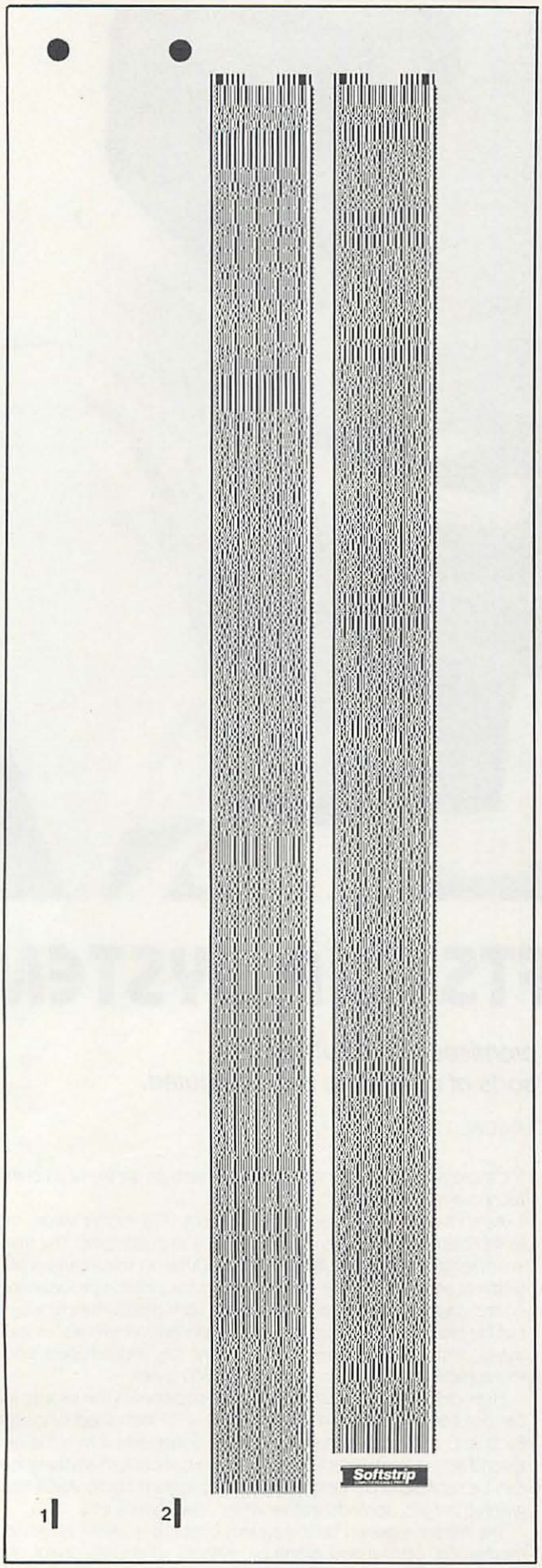
The Cauzin system is what the publishing industry has been looking for: an inexpensive yet reliable means of printing the software programs that eat up so much valuable page space. Bar codes were touted several years back as a possible solution. But bar codes never caught on because of their low data density, and because no low-cost, reliable bar-code reader became generally available for personal computers. However, a new technology that is similar, but vastly superior, to bar codes hopes to revolutionize the way that computer programs and other data are distributed.

Cauzin Systems, Inc. (a division of Kodak) has devised this new technology. Long narrow strips called Datastrips are the heart of this technology.

As shown in Fig. 1, each strip is about 0.78 inches wide; the length depends on the amount of data a strip contains. The maximum length of a strip is about 9 inches. Different strips can contain different amounts of data, depending on the printing process, and on the paper and ink used for printing. Low-density strips, which can be printed on any Epson *MX* or *FX* printer, contain about 1500 bytes; high-density strips, which must be reproduced photographically, can contain as many as 5500 bytes.

High-density strips printed on good paper with the proper ink can hold 60,000 bytes on a single 8-1/2 × 11 inch sheet of paper. Each strip can hold as many as 10 files; conversely, a long file can extend across as many as 255 strips. A file can contain anything that can be represented in eight-bit bytes: program code, ASCII text, graphic images, spreadsheet workfiles, data bases, etc.

The reader required by the system contains a highly-integrated mechanical, optical and electronic system, all under control of a



custom microprocessor (a TMS7040) and a custom VLSI IC. An internal view of the reader is shown in Fig. 2. In addition to the eight scanning lenses, 160 lenses are used for speed control.

The Softstrip

The physical makeup of a Softstrip is shown in Fig. 3. As you can see in Table 1, each strip contains 20 fields comprising a header area and a data area. Every strip contains fields 1 through 10; only the first strip of a file (or a group of files that extends across two or more strips) contains fields 11 through 18. Field 19 is the data area, and field 20 is an optional two-byte CRC (*Cyclic Redundancy Check*) code for error checking.

Each strip may contain from 2 to 6 bytes horizontally, plus one parity bit at each end of a line. Each line can be between ten and 40 mils high. Since each scan covers an area 2.5 mils high, the maximum resolution of the reader is 400 lines per inch. And since the thinnest data line is ten mils high, each data line is scanned a minimum of four times. Low-density strips with 40-mil lines are scanned 16 times.

Communicating with the reader

Cauzin has written communications programs for several popular microcomputers: the Apple *IIe*, the Apple *IIc*, the *Macintosh*, and the IBM-*PC*. Those programs can be used to read data strips automatically. However, if you want to read a data strip into a computer for which Cauzin has written no communications program, or if you're interested in getting at data strip files directly, here's some information that will help.

All you need is an interface cable, a computer with a serial port, and a communications program that can run at 4800 baud with 1

TABLE 1—CAUZIN SOFTSTRIP™ FIELD LAYOUT

Field	Length	Contents
1: Horizontal Sync		
2: Vertical Sync		
3: Data Sync	1	$00
4: Expansion Bytes	2	$00 See $00 Extended Description
5: Length	2	Two byte Hex length of total bytes following this field
6: Checksum	1	Binary Add with carry
7: Strip I.D.	6	A mandatory 6 byte ID field (preferably ASCII)
8: Sequence No.	1	Binary
9: Strip Type	1	Binary
10: Software Expansion	2	$0000 Binary (reserved)
11: Op. Sys. Type	1	Binary
12: Number Files	1	Binary
13: Cauzin Type	1	Binary
14: O.S. File Type	1	Binary
15: File Length	3	Binary lsb, nsb, msb order
16: Filename	Var.	ASCII Variable length name
17: Terminator	1	$00/FF Filename Terminator
18: Block Expand	Var.	$00 defaults 1 byte no info.
19: Data	Var.	File data information in consecutive blocks based on previous file lengths.
20: CRC	2	optional at strip end

NOTES: Fields 1 thru 10 occur on every strip
Fields 11 thru 18 are contained on Strip 1 only
File Directory Repeated Fields 13 thru 18
End of repeated file directory fields

FIG. 1—SAMPLE DATA STRIP contains a 6K BASIC program for printing a calendar for any year with a custom message. The program is also available on RE-BBS.

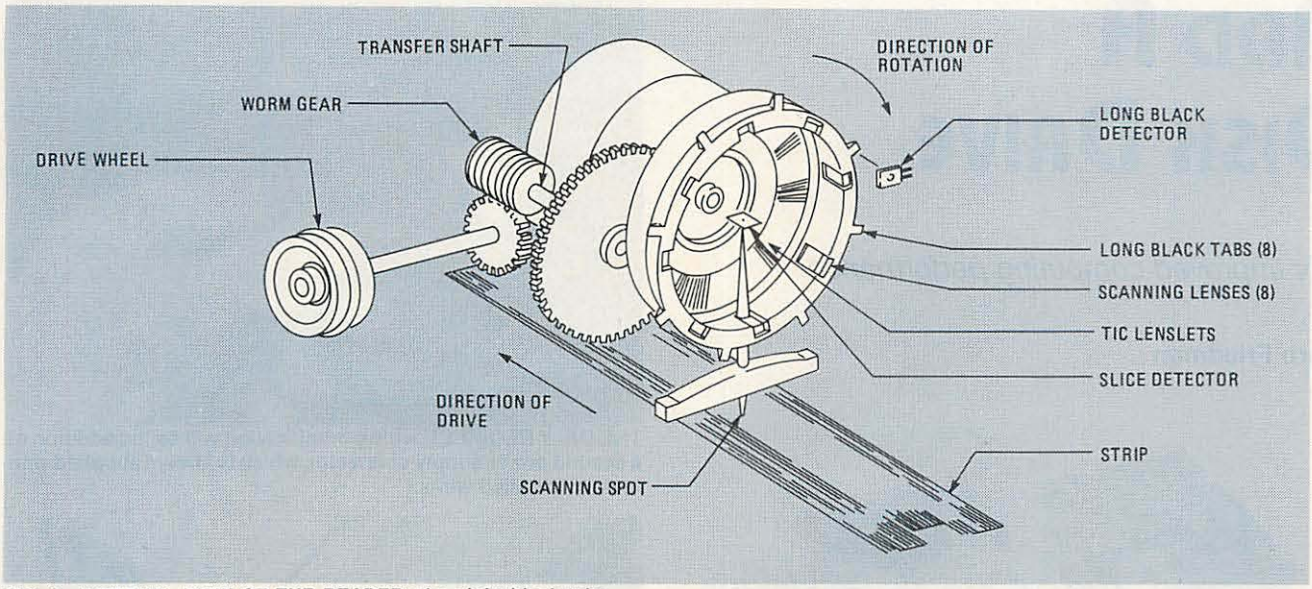


FIG. 2—INTERNAL VIEW OF THE READER: the eight black tabs provide horizontal-sync-like pulses for synchronizing the reader. All operations are controlled by a custom microprocessor.

start bit, 1 stop bit, and no parity bits.

The pinout of Cauzin's 6-pin modular plug is shown in Fig. 4. The reader can provide two-kinds of outputs: ±5-volt RS-232, and 25-mv Apple *II* cassette compatible. Pin 3 of the output connector determines whether RS-232 or cassette mode is active. The reader has a built-in pull-up to enable cassette mode; to enable RS-232 mode, just ground pin 3 (by connecting it to pin 6). Pin 1 provides a separate ground for the data input line in cassette mode; pin 4 provides a special signal we'll discuss below. To connect the reader to an IBM-PC, a *Macintosh*, or an *Apple*, follow the wiring diagrams shown in Fig. 5.

To read a Softstrip into a non-supported computer, you'll use the TERMINAL mode. Position the reader by aligning the circle and the bar by the Softstrip with the corresponding points on the reader. Then use your communications program to send the reader a "T" or a "t." The reader does not transmit an acknowledgement; rather the reader goes directly into the read mode. Use your communications program to capture the contents of the file in memory and then write the file to disk when transmission is complete. You can capture a file that extends across more than one strip simply by reading each strip in turn.

The Terminal mode is most useful for ASCII file transfers, because some file-header "garbage" may end up in the file. That garbage could create havoc in a binary object-code file. The communications program supplied by Cauzin transfers files cleanly, makes sure you read the strips in proper order, and performs other error checking.

Hacker mode

Notice in Fig. 4 that pin 4 of the reader's connector is labeled "Slice." Slice is a direct digital representation of the output of the scanner. By capturing the output of slice, you can digitize a rectangular region measuring about 0.78 by 0.5 inches. Possible applications include fingerprint analysis, digitization of musical scores, and handwriting analysis.

Note that the reader provides only the digitized signal; it's up to you to write the appropriate pattern-recognition software. However, Cauzin has written a special demonstration program that captures a digitized image in the memory of an Apple II computer. After an image has been captured, it can be saved to disk, printed, or displayed on screen. The hacker demo program is available from Cauzin.

The signal provided by Slice is purely digital: When the scanner is focused on a black spot, slice will be high (+5.0 volts). When the

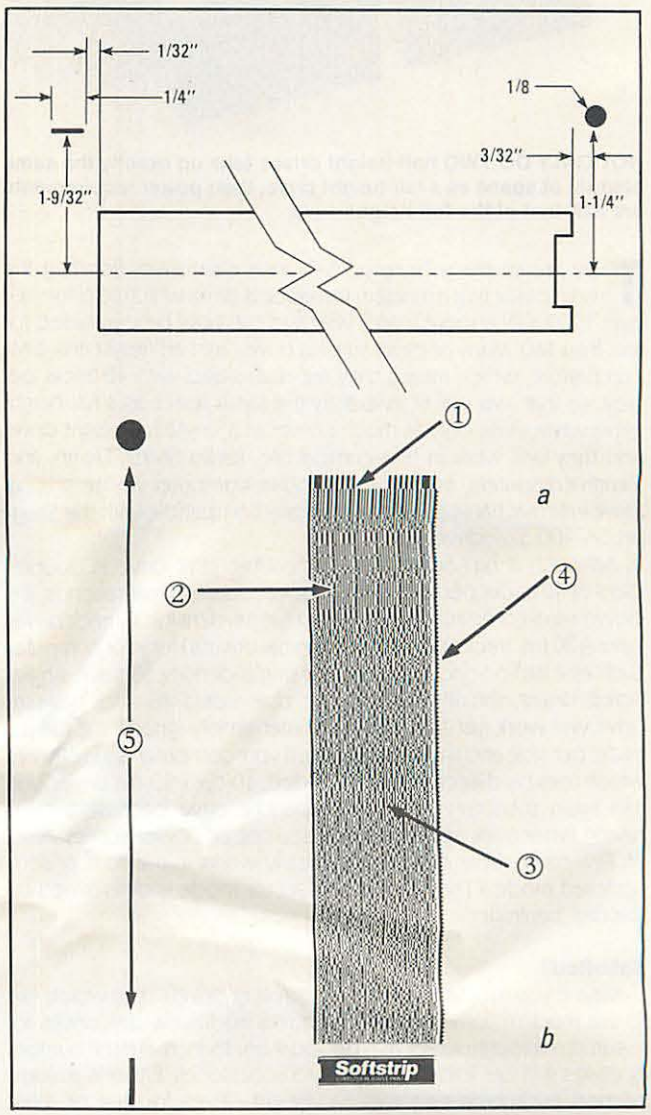
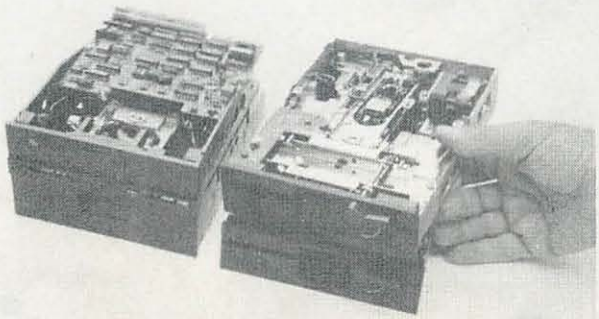


FIG. 3—THE SOFTSTRIP DIMENSIONS are shown in *a*. Its major areas are shown in *b*: (1) the header, which indicates paper and ink quality, number of bytes per line, and alignment; (2) the data section, which contains directory information; (3) the file section, which contains all data; (4) boundary lines, which keep the reader aligned and synchronized; (5) alignment marks.

Add A Disk Drive

For improved computing performance.

Herb Friedman



NOT ONLY DO TWO half-height drives take up exactly the same amount of space as a full-height drive, their power requirements are half that of the full-height drive.

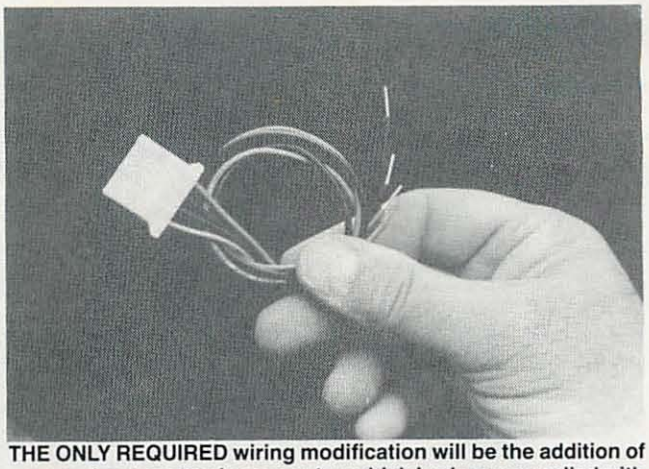
There are so many "surplus" 5-¼ inch disk drives flooding the marketplace that a modern fast-access drive which sold for well over $200 a little more than a year ago can now be purchased for less than $60. Many of these surplus drives are half-height and IBM-compatible, which means they are dual-sided with 40 tracks per side, so that two will fit in exactly the same space as a full-height drive while using only as much power as a single full-height drive, and they will work in IBM-compatible, Radio Shack, Heath, and Zenith computers, as well as any other computer whose original drive was machanically and electrically compatible with the Shugart SA-400 5-¼ drive.

Although a half-height IBM-compatible *disk* drive is double-density, 40 tracks per side, with a track access of 6 milliseconds, it is downward-compatible with earlier single-density, 35 track drives having 30 ms. track access. If the original drive(s) for your computer, such as a Radio Shack Model I, use single-density, 35 track, single-sided drives, the IBM-compatible dual-sided 40 track half-size drive will work just fine. The computer simply ignores the extra 5 tracks per side and the second side. If your computer is a Heath H8, which uses hard-sectored single-sided, 40-track 20-ms drives, you can again substitute an IBM-compatible drive because a drive having faster track access can replace one of slower access. Also, an IBM-compatible drive automatically works in the hard or soft-sectored mode. (The hard or soft sector mode is determined by the disk controller.)

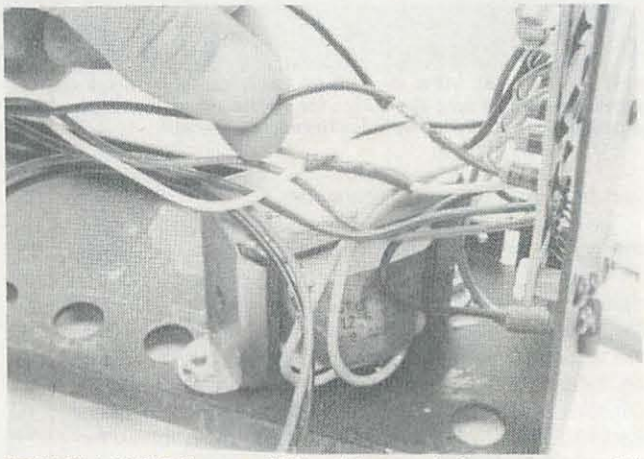
Satisfied?

Maybe you're satisfied with your present drive(s) but would like to use modern software which requires additional disk drives for maximum throughput; or maybe you want to increase the number of drives without installing outboard accessories. Either is accomplished by substituting two half-height drives for one or more internal full-height drives. If you have a Color Computer disk drive accessory it has 35 tracks, and 20- or 30-ms track access. The same cabinet and cable will accommodate two 40-track 6-ms drives. Since much modern software for this computer allows the user to select both the number of tracks and the track access time, you can almost double the track acess speed. If you have an IBM PC-compatible computer you could replace the A: drive with two half-height drives (A: and B:) and use the space (from the original drive B:) for an internal hard disk drive.

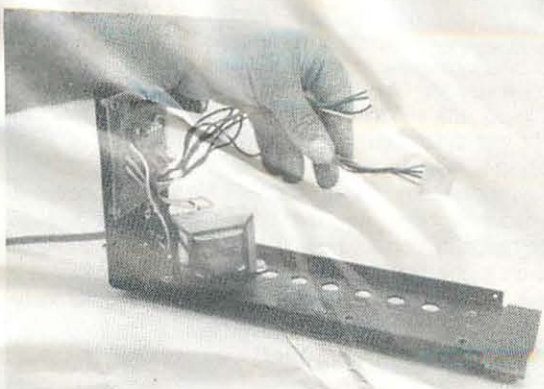
The physical installation of two half-height drives presents no problems because the power and signal connectors are "standard." You might have to drill new holes in the cabinet for the half-height's connectors. Simply flip the drive over so the connections are in the clear—there are mounting holes on both sides of the drive.



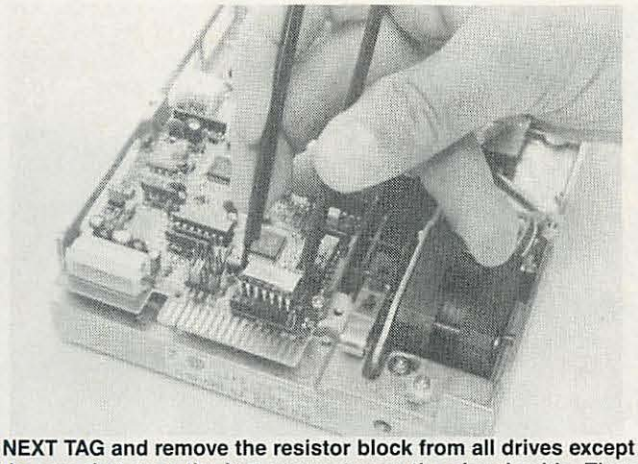
THE ONLY REQUIRED wiring modification will be the addition of a second power supply connector, which is always supplied with factory-installed wires.



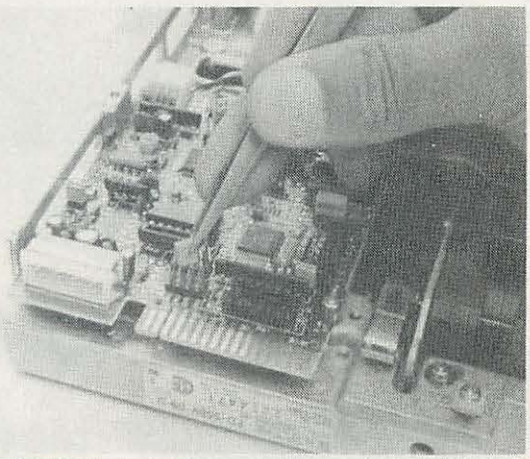
YOU WILL AVOID the possibility of damage to the power supply's printed circuit board if you splice the new power connector to the original wiring. Cut the tape to 3/16 inch so you can wrap several turns around the splice.



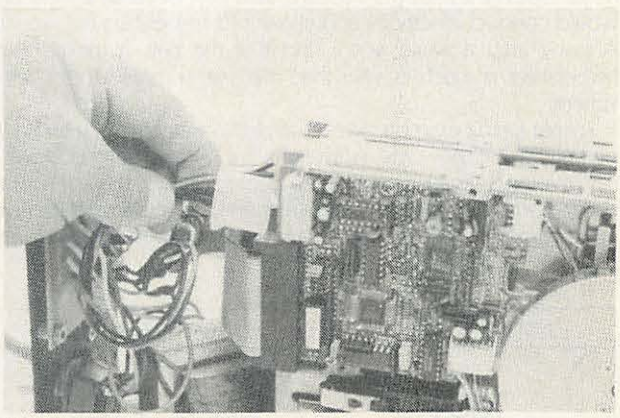
THE COMPLETED SUPPLY looks the same, but now there are two power connectors. Solder neatly, and don't remove unnecessary insulation.



NEXT TAG and remove the resistor block from all drives except the one that uses the last connector on the signal cable. Then mark the block.



USING TWEEZERS or needle-nose pliers, set each drive's DS *drive select* jumper to correspond to the jumper of the older drive being replaced, or to the required jumper pair if you're just adding an extra drive.

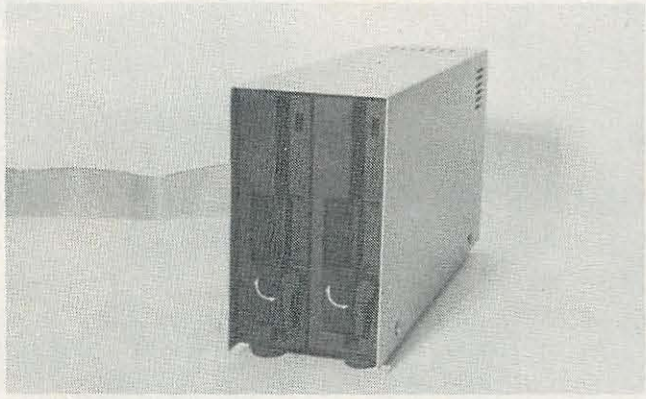


INSTALL THE DRIVE(S) and the signal and power connections. Make sure that matching power connector terminals are spliced together. One or more drives will probably be damaged if you reverse the end wires of a single connector.

Power connections

You will need to install an extra power connector for the extra drive. Do not remove the power supply assembly and drill new holes in the printed circuit board for the extra power wires because you can end up damaging the printed circuit board or one of the heat-sinked voltage regulators. A better way is to splice the wires for the new power connector into the wires leading to the original power connector. Don't attempt to match colorcoded leads because there is no color standard for a disk drive's power connector: Every color in the rainbow has been used. Since the connector is polarized, orient the old and new connectors in the same direction and then match the individual connections. To splice in the new wires, scrape about ¾ inch of insulation off an original wire, wrap the new wire around the old, solder, and cover with tape. If you offset each splice about one inch there will be no possiblility of a short if a strand of wire slips out from under the tape.

Since it's almost impossible to program one of the half-heights when two are substituted for a full-height drive, make sure you program the drive before it's installed in the cabinet. Programming means setting the drive select jumper and possibly pulling a termination resistor block. Older drives programmed drive selection through pins shorted by a jumper plug. Also, most no longer have HS and HL head-loading programming, nor a MUX connection. If



SECURE THE CABINET COVER and you now have two drives that occupy the space of one, both using the original cabinet and power supply.

they exist they are factory set at other pin-jumper terminals—which should never be changed by the user. If you don't know what a jumper is for, don't touch it.

The drive select programming for any 5-¼ inch disk drive is almost always located adjacent to the card-edge signal connections, which are easy to locate because they are labled DS0, DS1, DS2, and DS3. To program a half-height, look at your old drive and determine which one of the drive select jumpers isn't cut open. Then move the half-height's jumper to the same set of terminals, but keep in mind that the physical location might be different; on your old drive DS1 might be the third set of terminals, on the half-height it might be the first or second set of terminals. You are only interested in matching the DS connections, not their physical location. If your old drive also has HS, HL or MUX jumpers forget them. If your old drive has all DS jumpers set (Radio Shack does this for some computers because the selection is actually made by the pins of the signal cable's connector), you either must determine which is the one that's actually used, or short all DS pairs on the half-height drive.

Finally, there is the terminating resistor block. All drives are supplied with a terminating resistor, which resembles a socketed integrated circuit. It is generally located near the drive select jumpers. (If you can't locate the terminator block, phone the store that sold you the drive.) Only one drive per set of drives on a signal cable—usually the one at the end of the signal cable from the computer—can have the terminator; often, drives won't work if two or more drives are terminated. Pull the unwanted resistor block, but use an IC extractor tool so you don't damage the pins. You might need the block in the future. Not all resistor blocks are alike; a Brand X drive won't necessarily work with a resistor block from a Brand Y drive, so place a small label on each block before it's pulled so you know which block goes into which drive.

Basically, it takes longer to describe how to swap or retrofit half-height disk drives than it takes to do the job. The photographs show how easy it is to do a 2-for-1 half-height retrofit. If you plan your work carefully and solder neatly, soon you'll enjoy the convenience of dual disk storage.

BUILD THIS IBM INCOMPATIBLE

Build your own fully functional computer from discrete components.

JEFF HOLTZMAN

Like the early settlers of this country, the pioneers of the personal-computer revolution built their own. Legendary machines like the Altair 8800 and the SWTPC 6800 were built, like settler's houses, from whatever materials were at hand. There was no going into the local Computerland and saying "Yea, I wanna buy a machine to do the bills and maybe play a few games—just for the kids, you know. . . ." If one of those pioneers wanted to balance his checkbook, he had to write a program to do it—and in assembly language at that!

Nowadays people say that that pioneering spirit is dead, and that no one in his right mind would attempt to build his own computer. Well we think differently. We think that you can learn an enormous amount about computers (and, possibly, about psychiatry) by building your own computer. In fact, we think that, for the engineering or technical student interested in digital design, there is no better way to learn than by building your own computer.

So, in this 463-part series, we are going to teach you everything you need to know—from the ground up—about building your own computer. With the information we'll provide, you'll be able to put together a fully functional version of anything from an Apple II to an IBM-PC to a Cray I. So stay tuned.

Basic electricity

To begin our foray into the world of computers, let's discuss the basics of electricity. As everyone knows, there are two basic kinds of electricity, positive and negative. (See Fig. 1.) Due to the nature of the Earth's orientation with respect to the sun, electricity in the northern hemisphere is positive. If you're from "down unda," you have negative electricity. You can see for yourself how the two types of electricity differ by standing on the equator, extending your arms from your sides, and holding a large plastic pail in each hand. (See Fig. 2.) You must use a plastic pail, because a metal one would conduct electricity and allow it to leak out on the ground. Anyway, after a while, you'll find that the pail in the northern hemisphere is much heavier than the one in the southern hemisphere.

For our circuit examples we'll use positive electricity. Later on (in part 367) we'll show you a simple means of converting positive to negative (and negative to positive) electricity. But for now, if you live down unda, just reverse the orientation of all polarized components (diodes and capacitors), and substitute PNP for NPN transistors.

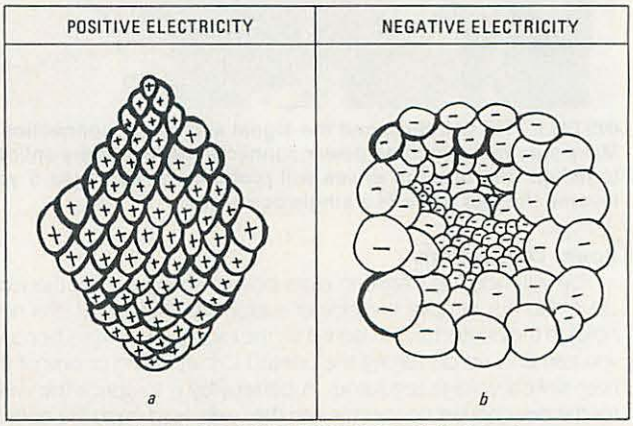


FIG. 1—THE TWO MAJOR KINDS OF ELECTRICITY. Other less-common types are not shown.

FIG. 2—POSITIVE ELECTRICITY falls on the northern hemisphere; negative electricity falls on the southern hemisphere.

Basic logic

Just as there are two basic kinds of electricity, there are two basic kinds of logic. Your choice of positive or negative logic, however, depends not on which hemisphere you live in, but on how obscure you want your circuit designs and programs to be. Due to the nature of the human mind, positive logic is inherently more comprehensible than negative logic. Positive logic is used more often than negative logic, but negative logic certainly has its uses. Sometimes, for example, if you're having trouble resolving a circuit into its proper logic elements, merely thinking about it in the opposite set of terms may suggest a solution. Or, if you're a student, you may be able to impress your professor by casting a circuit with negative logic elements. Or you may be able to confuse him so much that he'll have to admit you're a genius and place you on the dean's list. As we said, negative logic does have its uses.

There are three basic kinds of logic operations; it has been shown that many logic problems can be solved by combining them in various ways. The operations are the NOT, the AND, and the NAND. Their truth tables are shown in Fig. 3-*a*–Fig. 3-*c*.

NOT

INPUT	OUTPUT
1	0
0	1

a

AND

INPUTS		OUTPUT
A	B	
0	0	0
0	1	0
1	0	0
1	1	1

b

NAND

INPUTS		OUTPUT
A	B	
0	0	1
0	1	1
1	0	1
1	1	0

c

FIG. 3—TRUTH TABLES OF THE MAJOR LOGIC ELEMENTS. The NOT and the AND combine to form the NAND..

The NOT gate

The operation of the NOT gate will be familiar to anyone who is married. For lack of anything better to do, couples often take up opposite sides of an argument. It doesn't matter which side each person takes; in fact, often, the partners may in fact agree, or each may actually believe in the point of view the other represents. The important point is that for every "yes" there is a corresponding "no," and for every "no" there is a corresponding "yes." That is the essence of the NOT gate.

The AND gate

By contrast, the operation of the AND gate will be totally unfamiliar to anyone who is married. A two-input AND gate has the following property: for the output to be "yes," both inputs must be yes. Just as the two partners of a marriage almost never agree on the same thing at the same time, the AND gate is seldom used in practical circuits.

The NAND gate

The operation of the NAND gate should be somewhat more familiar. It is a combination of a NOT gate and an AND gate. For the output of a NAND gate to be "no," both inputs must be "yes." However, the output will be "yes" if either input is "yes." That is a very useful property.

Let's consider an example: suppose you want to buy a new computer, and your wife says no. If you had signed a marriage

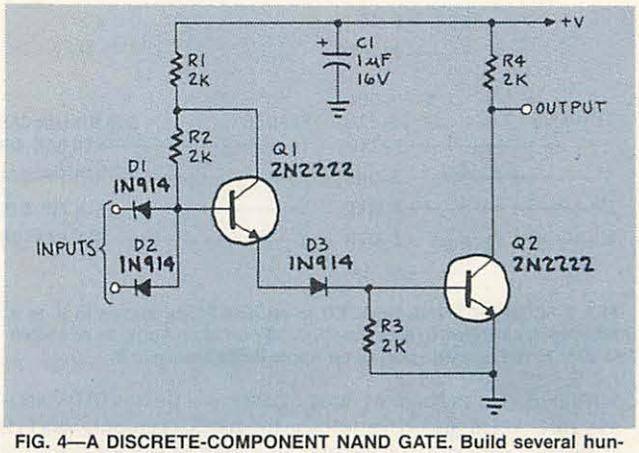


FIG. 4—A DISCRETE-COMPONENT NAND GATE. Build several hundred for next time.

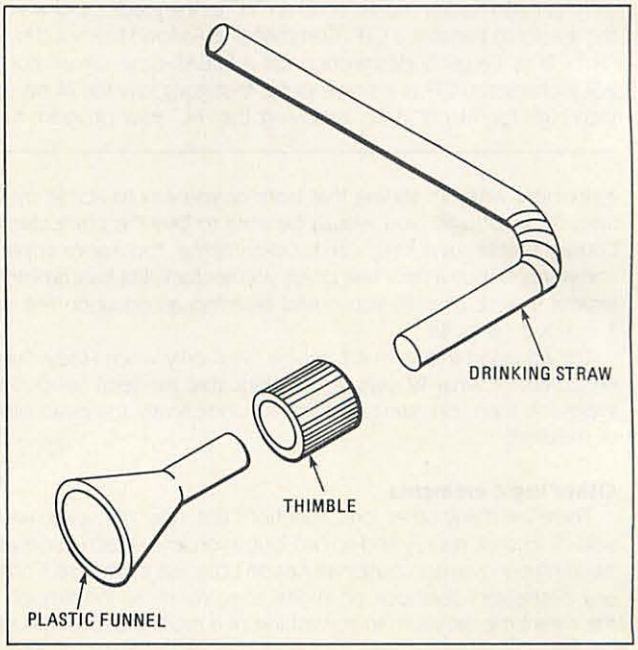


FIG. 5—POSITRON CATCHER. To decrease loss due to leakage, all components should be non-metallic. Use non-conductive epoxy to attach the parts together.

THE CAUZIN SOFTSTRIP SYSTEM

continued from page 95

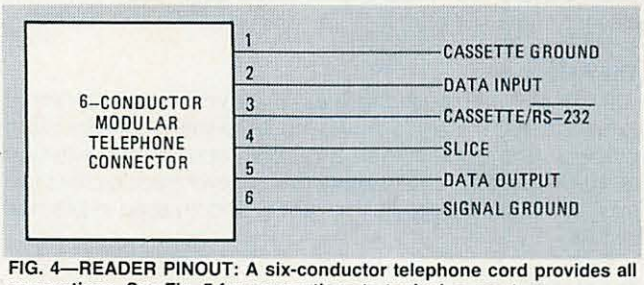


FIG. 4—READER PINOUT: A six-conductor telephone cord provides all connections. See Fig. 5 for connections to typical computers.

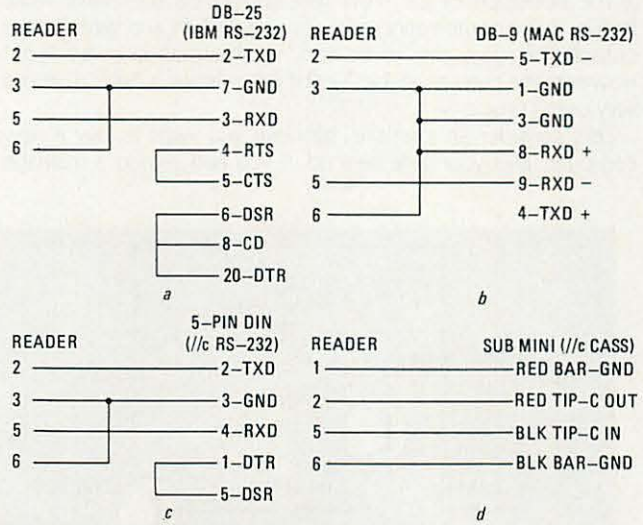


FIG. 5—CONNECT THE READER to an IBM-PC as shown in *a*, to a Macintosh as shown in *b*, to the RS-2323 port of an Apple IIc as shown in *c*, or to the cassette port of an Apple IIe as shown in *d*.

scanner is focused on a white spot, slice will be low (0.0 volts). To use slice, you'll also have to monitor pin 5, data out. Valid data appears at slice only when data out is high. In Hacker Mode, data out carries the signal that Cauzin calls Long Black. Long Black is similar to a TV's horizontal-sync signal.

To get into hacker mode, send an "H" to the reader, and wait for the reader to transmit a CTF (Command To Follow) followed by an "H." CTF is Cauzin's designation for a BREAK-type signal, not an ASCII character; CTF is a single pulse that goes low for 74 ms and then high for 74 ms. After receiving the "H," your program must send three 0E characters, at which point the reader will begin scanning. From that point on, it's up to you to capture and analyze the data.

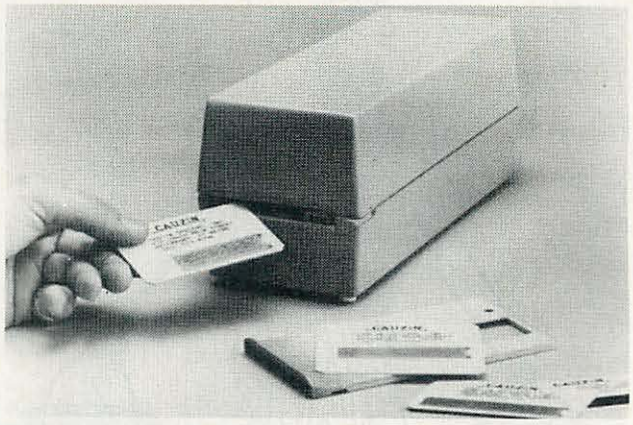


FIG. 6—HOSPITAL ADMISSIONS INFORMATION is contained in a Datastrip on a credit-card size piece of plastic. A special reader reads the data.

Other Uses

Datastrips can be printed in other forms. For example, they can be printed on credit card-like pieces of plastic and used for emergency-room admissions and other applications. For instance, all of a patient's relevant medical statistics could be printed on a small card. Use of the card, rather than a lengthy interview, can speed the admission process, and could mean the difference between life and death for a critically ill patient. A card and a special reader are shown in Fig. 6.

Softstrip datastrips can also be used to archive any sort of information. They are ideal for long-term storage because paper and ink are much more secure over long periods of time than magnetic media (disks and tape) and microfilm.

Conclusions

As you can see, Cauzin has packed a lot of smarts into a very small package. Whether the Softstrip system will catch on remains to be seen. However, many book publishers (Addison-Wesley, Houghton Mifflin, McGraw Hill, and many others) and many newspapers and magazines (including *The Village Voice, Byte, Keyboards, Computers and Software, MacUser, Nibble, Nibble Mac, Dr. Dobbs,* and many others) have already begun to print software in strip form, and we're considering it too. Let us know what you think. If reader response warrants it, you'll soon see much of our software in that form.

---

agreement with her stating that both of you would abide by the rules of NAND logic, you would be able to buy the computer. Of course, simple NAND logic can be detrimental, too. For example, if she wants to buy a new hair dryer, you're stuck. But by combining several logic elements, you could develop an equation like this: $\bar{T}$ = H AND (W OR $\bar{W}$).

The equation shows that T will be "yes" only when H says "yes," regardless of what W says. If you think that the term (W OR $\bar{W}$) is irrelevant, then you don't understand completely the psychology of marriage.

Other logic elements

There are many other logic functions (OR, NOR, XOR, XNOR, MAYBE, SORT-OF, KIND-OF, YES BUT, and so on), but, in order to reach our goal of building our own computer, we needn't discuss them here. Consult any elementary textbook on digital logic for more information. In the meantime, let's turn to something of a more practical nature.

Basic NAND circuit

A two-input NAND gate is shown in Fig. 4. As we stated above, both inputs must be "yes" for the output to be "no." We're using positive logic, so a "yes" corresponds to a high, and a "no" corresponds to a low (ground). The values of the resistors will depend on the voltage you use to power the circuit. We'll show you how to build your own positron catcher (for generating positive electricity) below. But for experimental purposes, you could use a nine-volt battery and 2K resistors.

Project goals

The NAND gate is the basic building block of many digital computers. Whatever kind of computer you want to build, you can be certain of one thing: you'll need many NAND gates. You can start building now, and, if you change your mind later on, that's OK. Provided you use a reliable interconnection scheme, you can always reuse the gates you build. Of course, if you're sure you want to build, say, a Cray, you can get much better prices for the parts you buy, by buying in large quantities. Here are our estimates for the number of gates you'll need to build various computers. To build a Cray supercomputer, about 10^{50} gates. To build an IBM-PC, about 10^{10} gates. To build an Apple II, three or four dozen gates should

R-E Computer Admart

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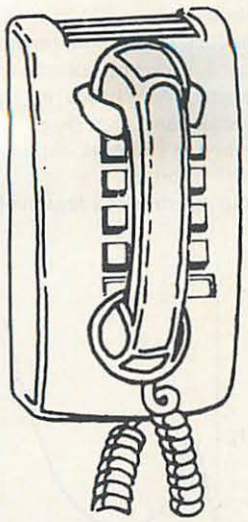

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suffice.

If you have a different computer in mind, that's just great. We encourage experimentation, and would welcome design details. Send your ideas to the Managing Editor.

Construction

After verifying that your circuit works, you'll want to start duplicating it. Each gate could be built on a separate piece of perfboard, using spring-loaded terminals for connections. You'll need five terminals per gate (two for inputs, one for the output, and two for power and ground). However, if you're planning to build one of the larger computers, you may want to build many circuits (hundreds, or even thousands) on each card. The connections between the gates on each card could be soldered, and the cards might be interconnected via spring-loaded terminals.

The size of the positron catcher you'll need also depends on the computer you'll build. A filled household bucket will provide several hours of experimentation using several hundred gates. You can use a funnel, a thimble, and a drinking straw, as shown in Fig. 5. Drill a ⅛-inch hole in the thimble, and then use epoxy to glue the thimble to the funnel, and the straw to the thimble. Be careful not to clog the straw!

If you're planning to build a Cray, try to obtain a 10,000-gallon fiberglass tank. You may be able to buy one cheaply from an out-of-business gasoline station. For the sake of efficiency, you should use something larger than a household funnel to catch positrons. If you can locate your catcher on top of a mountain, you'll avoid the dissipating effect the atmosphere has on positron energy.

Conclusion

The power of simple digital logic elements can be surprising at times. And that is the goal of our series—to show you just how much you can do with a few (or many) simple gates. For next time, start building gates. You should have at least several hundred on hand so that we can start building the most important part of any computer: the ALU (*Arithmetic Logic Unit*).

One problem you may run into is time. While the gates are easy to build, it's tough to build several hundred in just a month. So that we don't leave anyone behind, we'll delay publishing Part 2 until April, 1988. See you then.

R-E ROBOT

continued from page 44

stall the watchdog timer (IC43) and JU15, and set the timeout for approximately 1 second (by substituting a 1-megohm resistor for R19). Do not install any other IC's. Apply power and confirm that the oscillator is operating by observing the signal at pin 56 of the microprocessor. Pin 24 of the microprocessor should go low each time S2 is pressed and each time IC43 times out. If those operations appear normal, remove power and install a ROM with a simple JMP −1 instruction where the reset vector normally goes (FØØØ:FFF Ø). Now, if all is well, you should see a nice tight loop by observing the address bus on an oscilloscope.

You can trigger your scope easily on that signal and actually use your scope as a poor-man's bus analyzer. Observe the RD line and select a cycle for analysis. Note the exact position of the RD strobe on your scope. Now probe the DØ line. Is it high or low when RD is low? Write it down. Do the same for all of the data and address lines. You have just decoded the entire state of the microprocessor for that RD cycle: the address being read and the next instruction in the ROM.

Next, fill a ROM with NOP's (Ø9Øh) and execute a jump to the beginning of the ROM. Scope the address lines. You should see a ØlØl sequence on AØ, a ØØ11 sequence on A1 and so on. Each address line will appear at half the frequency of the preceding line.

What if things are not as they should be? This is where the watchdog timer (IC43) comes to our rescue. Set it for a timeout of a few milliseconds, trigger your scope on the reset pulse from the microprocessor (pin 57), and observe the first few RD cycles at the ROM. Here are a few things to look for:

1. Is the chip select line to the ROM (pin 20) active? If not, there could be a problem in the address-decoding circuitry or the address latches. Perhaps one or more of the microprocessor signals ALE, DEN, DT/R, RD, or WR are lost.

2. Are the address lines correct? They should all be high except for AØ–A3; those lines will toggle. Watch for voltage levels that are neither high nor low; two lines may be shorted, or the address decoder may not be functioning correctly.

3. Decode the first few instructions on the data bus. Do they accurately represent the contents of the ROM? Are the voltage levels correct? Incorrect voltage levels are caused by bus contention, shorted traces, ungrounded IC's, unpowered IC's, capacitors attached to data lines, and many others we have not (yet) had the pleasure of encountering.

continued on page 108

EARLY RADIO

continued from page 61

The end of spark

Another important milestone in the development of radio was the development of a generator capable of producing a high-frequency, continuous-wave carrier. That is, a carrier that could be modulated by sound.

Early radio transmitters were of the spark type. They could produce only a damped wave, which is very broadband and electrically noisy. Because of those characteristics, spark was suitable only for wireless telegraphy.

In 1889, Elihu Thomson of General Electric produced a high-frequency dynamo. Later, Nikola Tesla also produced such a dynamo. However, both had a maximum frequency of only about 5,000 cycles.

By 1903, Charles Steinmetz had built a 10,000-cycle alternator. In 1904, Reginald A. Fessenden conceived the idea of an alternator that would be capable of reaching a frequency of 100,000 cycles. Assigned to the project by General Electric, Ernst F. W. Alexanderson attempted to build such a device. He was eventually successful, although only after repeated failures.

The first transmission of a human voice took place on Christmas Eve, 1906. The continuous-wave carrier was generated by an alternator with an operating frequency of 50,000 Hz and a power of 1 kW. The microphone was a water-cooled unit. The historic event was not accompanied by much publicity, and 14 years would elapse before the beginning of scheduled radio broadcasting in the U.S. in 1920.

Tuned circuits

Spark did have one advantage: receivers did not need any type of tuning mechanism. For continuous-wave signals to be useful, some means of tuning would be required. Sir William Crookes' article, "Some Possibilities of Electricity" published in the *Fortnightly Review* in 1892, called attention to the need for tuned circuits. He wrote, "What remains to be discovered is a means of generating waves of any desired wavelength, and receivers which will respond to wavelengths between certain defined limits and be silent to all others."

That idea was put into action by Sir Oliver Lodge, who started experimenting with tuned receivers and transmitters in 1897. He called his method "syntonized tuning achieved through the use of capacitors." With the development of continuous-wave transmitters, and tuned receivers that could receive their signals, the first stage of the electronics revolution was complete. **R-E**

SEMICONDUCTOR TESTING

continued from page 64

as high-current rectifiers in low-voltage applications.

As the forward bias on the tunnel diode is increased, however, something interesting happens. As shown in Fig. 7, the current peaks and then drops into a deep valley, only to increase exponentially in traditional fashion.

The dip constitutes a region of negative

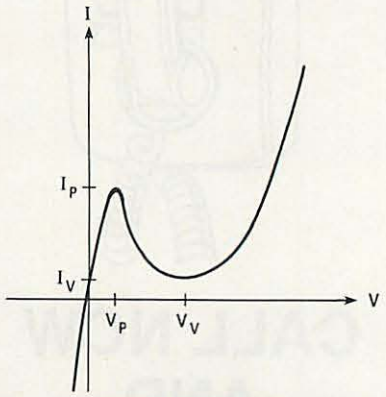

FIG. 7—THE TUNNEL DIODE is characterized by a rapid rise in current followed by a dip; when operated in the latter region, the diode can function as an oscillator.

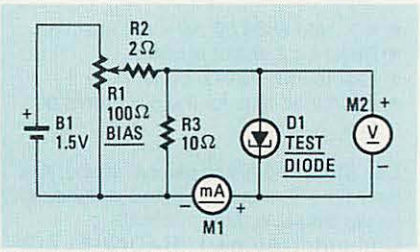

FIG. 8—MEASURE TUNNEL-DIODE characteristics using this circuit.

resistance, i.e., increased voltage leads to decreased current. By exploiting that characteristic, the tunnel diode can be made to oscillate in the relaxation mode. The small physical size of the tunnel diode permits oscillation into the hundreds of megahertz with simple circuitry and minimum power dissipation.

Tunnel-diode characteristics can be measured easily with a voltmeter and a current meter, as shown in Fig. 8. Bias voltage is increased with R1, and the rise in current noted. At some point (V_P), current will plunge suddenly, and voltage will increase by several hundred millivolts. Those characteristics represent valley current (I_V) and valley voltage (V_V), respectively. Typical readings are 100 mV at 1 mA for the peak values, and 350 mV at 0.1 mA, for the valley values. The I_P to I_V ratio should be no less than 6 to 1.

That's it for this month; next time we'll look at thyristors. **R-E**

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